



**ESKİŞEHİR TECHNICAL UNIVERSITY**  
**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**  
**EEM 413-414 PROJECT LIST FOR 2021-2022 FALL SEMESTER**



PROJECT ID	PROJECT TITLE	ABSTRACT	TEAM QUALIFICATIONS
PRJ001	Design and Implementation of Virtual Electrical Machinery Laboratory	<p>Purpose of this project is to design &amp; develop necessary software and algorithms for modelling and testing electrical machinery devices in virtual laboratory conditions. Such as: Synchronous, Induction and DC machines. Teams are going to design and implement the entire system in necessary software and web platforms. We want to see the system running on a simple real life application such as a testing laboratory in web page medium.</p>	Power systems (2 Student), Programming (1 Student) Web page design (1 Student)
PRJ002	Intelligent lighting with environmental monitoring and parking management	<p>One of the issues of smart urbanism is to reduce the electricity consumption and the light pollution of the streetlights. However, they are also ideal places to install monitoring systems to collect data for smart cities. Therefore, beyond energy efficiency and advanced lighting capabilities, networks of smart streetlights can be considered as the foundation of the data-driven intelligence of powerful smart city applications. Smart streetlights can be outfitted with a vast array of sensors and cameras to collect critical data and improve city useability for residents. On top of the Internet of Things (IoT), streetlights can communicate wirelessly (e.g., NB-IoT, Wi-Fi,5G) or using power line carrier PLC-IoT while monitoring environmental parameters (e.g., temperature, humidity, noise, air pollution), traffic conditions, pedestrian activity, potential security risks, and more. In the scope of this project, motion-dependent lighting (dims when no activity is detected but brightens when movement is detected) is aimed to reduce electricity consumption and wastage of energy. As with all similar projects, when a passer-by is detected by a camera or sensor, it always should be surrounded by a safe circle of light (with differences depending on whether it is pedestrian or vehicle) by adjusting the neighboring streetlights with a smart approach. During the movement of a passer-by, trailing lights should be turned off after a delay, and the lights ahead of the passer-by should illuminate at a longer distance. It is also aimed to adjust the brightness of the streetlights according to time and environmental factors. This type of lighting is different from stationary illumination, or dimmable street lighting that dims at pre-determined times. In this way, lighting can be used more efficiently, with less waste and less creation of unwanted or unneeded illumination. In addition to all these, information about predetermined parking spaces can be collected in the on-street environment with video monitoring or sensors. In the light of this information, many of the parking problems of the cities can be prevented with a parking guidance system in line with the city's needs. The system with all these purposes is intended to be built on an existing lighting network.</p>	Signal and image processing & Software development(1 Student) Control systems(1 Student) Power systems(1 Student) Telecommunication(1 Student)
PRJ003	Haptic Feedback Obstacle-Detection Travel Aid System	<p>This Electronic Travel Aid (ETA) project aims to enable the users to sense the profile of their surroundings and navigate around objects in their paths. The device to be developed will provide spatial information about a small area around the users on the move via haptic feedback. Lidar and/or time-of-flight (TOF) sensors will be used to obtain range information and identify the obstacles. Additionally, accelerometer and gyroscope sensors will also be used for basic human motion tracking. Mini vibration motors to be placed on the user's arms will be used for haptic feedback to assist with mobility planning. All information will be mapped to the vibration intensity of vibration motors against the user's skin. To enable the user to identify the location and general profile of the objects to be detected, the range to be scanned will be mapped by nodes and the motors will be placed on the arm sleeves according to this mapping. Various strengths of vibration and a dispersion approach will be used to indicate proximity so that the user can sense the change in distance from the obstacle and steer away from the obstruction. The dispersion approach will be used to indicate which node a detected obstacle may enter in the continuation of the movement.</p>	Signal processing(1 Student) Embedded systems/Software development(1 Student) Control systems(1 Student) Electronics design(1 Student)

PRJ004	Design and Implementation of RF-Based Vital Sign Monitoring System	Respiratory rate (RR) is one of the most important vital signs that reflect the health status of people. It can be lifesaving to continuously monitor the RR, especially during sleep. Conventional methods to monitor RR require physical contact with the human body, which are not suitable for long-term monitoring at home since they restrict the movements of people. The monitoring of RR will be more crucial especially in the age of Covid-19 with a contactless (device-free) system. Radio-frequency (RF) signals have a great potential to be used in contactless healthcare systems. The purpose of this project is to design and develop a system that uses wireless RF signals to monitor vital signs in real-time with low-cost commercial RF devices. The desired system can include both conventional signal processing and machine learning techniques.	Signal Processing/Machine Learning (1 Student) Telecommunication (1 Student) Embedded Systems (1 Student)
PRJ005	AI-based Smart Zoom for Military Applications	Increasing the spatial resolution of an image or video can be a very important application in security or military applications. For example, a drone for military surveillance (UAV) needs expensive and bulky lens systems to produce high-resolution images with good detail from a safe altitude. For this reason, it will be of great benefit to replace this lens system with artificial intelligence supported software in order to provide high resolution images. The most basic form of this process is called upsampling and is accomplished by interpolation methods. These methods do not use multiple images or external data as they try to estimate the values of new pixels using only the existing data in the image. Super resolution, on the other hand, aims to obtain a high-resolution version of an input image, solving the same problem by using available information from multiple images of the same scene. In recent studies, machine learning methods are emerging to enable the use of data from large databases to obtain a high resolution image. In this project, potential teams will develop AI architectures for super-resolution applications and optimize them so they can run on edge devices.	Computer Vision (1 Student) Machine Learning (1 Student) Image Processing (1 Student)
PRJ006	Monocular vision-only navigation for automatic guided vehicles	Automatic guided vehicles (AGVs) usually run within facilities and factories for transportation of products and materials, where GPS signals are unavailable and path movement precisions are required to be centimeters. Current technology uses LIDAR and depth sensors to move along a route while avoiding obstacles. An option proposed last year was to avoid obstacles by camera vision and obtain route information via QR codes. This year, the team will work on construction of the 3D environment information from the mono camera while AGV is moving, and matching it to the map layout of the factory. Together with obstacle avoidance parameters, QR codes will not be necessary and the AGV is expected to be totally autonomous. The team will work on an Nvidia Jetson system attached to an actual AGV.	3 Students "Signal Processing" with strong background on: Embedded systems (1 Student) Image processing (1 Student) Machine learning (1 Student)
PRJ007	A transform-based multiplier-free deep neural network for autoencoder architectures	Despite the popularity of deep neural networks, computational cost of training regardless of the architecture remains to be a problem. Performing binary-only operations is shown to improve computational speed at the expense of reduced accuracy. There are also architectures that use "transform-based" neural layers. In this project, we will explore transforms that use only binary operations (such as Haar or Hadamard transforms) which can be installed into deep network layers, or even replace them. Several learning applications, including difficult medical image databases, will be tested.	3 students Signal processing, with strong background on image processing and preferable machine learning. Strong programming capability is suggested.
PRJ008	Design of an ML based smart charging reservation system for EV parking lot.	In metropolitans, the problem of finding available parking slots has changed as finding available parking slots having charging stations due to increasing electric vehicle (EV) deployment. Smart management systems can be used in this manner for obtaining an optimum parking slot in EV parking lots (PLs) considering EV users' preferences. This purpose of this project is designing a smart reservation system considering the behavior of EV users, parking slot availability (PSA), state of charge (SoC) value of EVs, and PL usage history of EV users. To do this, a machine learning (ML) algorithm will be used in the smart reservation system.	Programming (1 Student) Machine Learning (2 Student) Note: Probabilistic data processing is necessary capability for this project.

PRJ009	Practical design of antennas for wireless devices using commercial electromagnetic simulation software.	The aim of this project is to initiate the students into the use of electromagnetic software tools like HFSS and CST to design antennas for multi-standard wireless applications. At the end of the project, students will be able to develop their own compact antenna designs for wireless terminals working with GSM, UMTS, LTE, Wifi, Bluetooth, WiMAX and UWB, 5G, MIMO systems. Knowledge of the use of these commercial electromagnetic packages would help the student to face the design of other electromagnetic structures as waveguides and microwave circuits/devices.	Telecommunication (2 Students), Antenna Design (1 Student)
PRJ010	Design and Implementation of a Smart Plug	Purpose of this project is to design & develop a smart plug which can be used for measuring the power consumptions of electrical devices. This plug can be easily plugged into the wall outlet. It can be communicated with any wireless devices at home. Users monitor the measurement power and energy results by using mobile devices	Power (1 Student) Signal processing (1 Student) Control(1 Student). Note: Programming capability is needed.
PRJ011	Design and Develop Wireless EV Charging Facility	One of the barriers of spreading EV usage is charging duration. There are several types of charging stations (CSs) as AC CSs, DC CSs, Wall CSs etc. On the other hand, wireless charging is new upcoming technology for EVs. Purpose of this project is to develop a wireless EV charging facility. To do this, project team is going to implement an efficient wireless charging facility using appropriate power electronics and electromagnetic technologies.	Power Electronics (1 Student) Embedded systems (1 Student) Electromagnetic theory (1 Student)
PRJ012	State and Parameter Estimation for Lithium-Ion Batteries	The use of Lithium-Ion batteries gained pace during the last decade. There are several reasons for this increase in use and these batteries can be seen as energy sources almost in every application. In this project, the goal is to design and create a simple, efficient and low-cost system (embedded) for state and parameter estimation of Lithium-Ion type batteries. State of Charge (SOC) and State of Health (SOH) can be obtained for a specific type of lithium battery efficiently based on these states and parameters. If sufficient time remains, the effect of shock, vibration, temperature etc. on these states and parameters will also be investigated.	Control Systems (1 Student) Embedded Systems (1 Student) Software Development (1 Student)
PRJ013	Investigation of a sensor fusion methodology based on Encoders and IMUs for accurate displacement estimation of mobile robots	The current position of a mobile robot (or vehicle) can be estimated from its previous position and velocity measurements over time, and it is called dead reckoning. The common method for this purpose is to consider encoders. However, two problems of this approach are the drift and slip of wheels. In this project, a sensor fusion method will be investigated to increase accuracy of this traditional method. IMU (inertial measurement unit) generally consists of gyroscopes and accelerometers. Position and velocity of the robot can also be determined based on IMU. Investigated methodology will be applied to a primitive mobile robot structure and the results of this approach will be compared to encoder based standard method.	Control Systems (1 Student) Embedded Systems (1 Student) Software Development (1 Student)
PRJ014	Triboelectric Energy Harvester Based Self-Powered Sensors	The aim of this project is to design a triboelectric energy harvester. The working principle of triboelectric energy harvester is based on statistic charging of two surfaces. When two materials that differ in being electron donor or acceptor undergo periodic contact and separation, the generation and transfer of electrostatic charges cause a potential difference between oppositely charged surfaces thus driving an alternating current flowing through an external load. Here, students are expected to develop wearable energy harvest devices capable of converting mechanical energy to electrical energy for emerging self-powered sensor applications.	Electronics (2 Students), Digital Systems (Software Development) (1 Student)
PRJ015	Route Tracking for Mobile Robot	The purpose of this project is to design a controller that tracks the given route for mobile robot which is "Lego Mindstorm EV3". The steps of this study are given as follows; reading visual route from file, converting visual route file for lego EV3, designing a controller, obtaining a closed loop system and achieving simulation and real-time application results. This design will be realized on MATLAB; by applying the given route for lego EV3 will be provided to follow it.	MATLAB Simulator Design (1 Student), Controller Design (1 Student) System Modelling (1 Student)
PRJ016	Sensor Array Application for Elderly People	If elderly live alone, elderly care at home is a major concern since unforeseen circumstances might occur that can affect their well-being. Developing new technologies that assist the elderly in independent living is important for smart home systems. In this work, a sensor array will be developed to observe the environment and activities of elderly.	Signal Processing (1 Student) Machine Learning (1 Student) Programming (1 Student)

PRJ017	Automated Optical Fiber Alignment System	The project aims in development of automated self-alignment system which will enable coupling of laser light into an integrated optical chip. The same system will also guide the laser light into an Optical Spectrum Analyzer (OSA) and photodetector. The alignment will be obtained through an algorithm which will be developed and implemented using special software such as LabView. The hardware to be controlled simultaneously consists of two 3-D motorized stages, diode laser controller, photodetector, and Optical Spectrum Analyzer. The project will be conducted in a research lab environment.	Electronics (2 Students) Note: The interest and success in EEM210 and EEM403 are critical for the implementation of the project.
PRJ018	SmartNIC Design (Akıllı Ağ Arayüzü Denetleyicisi Tasarımı)	Previous generation of network interface cards (NICs) are not smart meaning that they are only responsible determining whether forwarding a network packet to the CPU or not; and also performing only basic network connectivity functions. Contrarily, SmartNICs perform some specific computations on the incoming packet to offload some network functions from the server processor in order to free a lot of CPU cycles for higher performance and energy efficiency. Some of the high-speed networking tasks are more efficient when their computations are realized in application-specific digital circuit rather than implementing in software (CPU/GPU/TPU/etc.). E.g., encryption or decryption procedures are just example tasks that are (software) CPU-intensive. Offloading CPU-intensive tasks to reconfigurable hardware will save a lot of CPU cycles. Hence, FPGA-based SmartNIC devices allow users to create their own custom hardware architecture to save CPU cycles and save CPU power for some custom applications. Today, Microsoft Azure has recently determined that FPGA-based SmartNICs are the potential technology in the next computing paradigm in the cloud. There are a lot of potential tasks that can be accelerated by a SmartNIC from networking, storage, and security perspective. SmartNICs are able to implement several security features like cryptography, packet inspection or blocking DDoS attacks before servers get overwhelmed. In this project, your aim is to improve the performance of an application of your choice with exploiting a reconfigurable SmartNIC device. You need to connect many FPGA cards (2 or more) together and show a superior performance in your selected networking application. Hardware acceleration in VHDL/Verilog level and also experience in programming in C level is a mandatory ability to complete this project. Students who select this project can determine any networking task that needs to be accelerated for their selected application. Application is arbitrary; e.g., a blockchain application, security application, an artificial neural network application. They can work in the cloud FPGA devices (AWS F1) or local FPGA devices (Zed Boards we have in our laboratory).	Digital Systems (4 Students)
PRJ019	Characterization of a 2-Dimensional Material Based Phototransistor and a Memristor	Purpose of this project is to understand and characterize a phototransistor which is fabricated by using 2 dimensional materials in the MIDAS laboratory of Eskişehir Technical University. Mainly. The probe station in the lab will be utilized for electronic transport measurements of the device. Team members are going obtain the current-voltage (I-V) characteristics and main performance parameters of the phototransistor including photoresponsivity, ON-OFF ratio, detectivity, mobility and etc. The I-V measurements can also include temperature dependence and wavelength dependence. Also, the operation a memristor will be understood.	Electronics (2 Students) Note: The interest and success in EEM210 and EEM321 are critical for the implementation of the project.
PRJ020	4'th to OKEY	Purpose of this project is to design & develop necessary software for playing interactive OKEY game. The platform will be chosen by the team (either Android, Apple or PC) and 4 people can play interactive OKEY game. During the game it is necessary to have online chat. The conversations during chat talk must be clearly understood. Although it is not necessary, the captured video images of the gamers can be shared.	Software design for user interaction (1 student ) Server Database management and Network protocols for gaming (1 student ) Software development for chat platform (1 student )
PRJ021	Design and implementation of a remote patient monitoring system	Remote patient monitoring (RPM) is a technology to enable monitoring of patients outside of conventional clinical settings (e.g. in the home). In this project, a team of students is expected to design and realize an RPM system that is composed of an embedded system and a body area network based on a set of non-intrusive sensors. The system should be capable of collecting a wide range of health data (such as vital signs, weight, blood pressure, blood sugar, blood oxygen levels, heart rate, and electrocardiograms) and transmitting several alerts and the collected data to a server application running on a mobile device and cloud data center.	Embedded System Software+Hardware (1 Student) + Mobile Software (1 Student) + Cloud Software (1 Student)

PRJ022	Specification and Design for Self-Driving Cars	Increases in fast and inexpensive computing and communications have enabled a new generation of information-rich control systems that rely on multi-threaded networked execution, distributed optimization, sensor fusion and protocol stacks in increasingly sophisticated ways. This project aims to provide working knowledge of methods for specifying, designing and verifying control protocols for autonomous systems, specifically self-driving cars. The methods from computer science (temporal logic, model checking, reactive synthesis) with those from control theory will be used to analyze and design partially asynchronous control protocols for continuous systems. A software toolbox, TuLiP, that is designed for analyzing and synthesizing hybrid control systems using temporal logic and robust performance specifications will be used in the project	Software Development (1 Student), Embedded System (1 Student) Control Systems (1 Student)
PRJ023	Balance and control of in rear wheel steered bicycle	Front driven bicycles have the disadvantage that the front driving induces unwanted steering and that the frontal area of the bicycle cannot be reduced any further. A solution would be rear-wheel steering. A common thought is that a rear-wheel steered bicycle cannot be laterally self-stable, and therefore hard to control. The design concept is rear wheel steering front wheel drive recumbent with power transfer system directly on front wheel. The design is a try to adapt recumbent bikes within the existing design constraints for urban use and change the nature of this bike from sports cycling to urban transportation cycling.	Embedded System (1 Student) Control Systems (2 Student)
PRJ024	Energy Management System Design and Implementation of a Practical Smart House	Smart houses refer to a home where a set of interconnected devices and household appliances perform certain actions to monitor energy, optimize the use of energy and thus save money. Smart homes are also systems that meet their needs in smart and flexible ways, respond to the needs and comfort of their residents, and enable them to control and manage the consumption of their own green energy resources. The objective of this project is to construct a cost effective energy management system design and implementation of a practical smart house for smart cities.	Power Systems (1 Student) Embedded systems (1 Student) Machine learning (1 Student)
PRJ025	Constructing an experimental Setup	Coupled nesystems appear in various applications. In this project, a network of chaotic circuits will be constructed. First, the existing chaotic circuits will be tested. Then, in order to connect the outputs of the circuits to the corresponding inputs of the DAQ card an interface circuit will be designed. Then, a rack will be designed to put the circuits properly to avoid possible short circuits. Finally, some experiments will be done	Control Systems (1 Student) Electronics (1 Student) Signal Processing (1 Student) Note: It is expected from the students have capability to make soldering, and understand measurement and instrumentation
PRJ027	Control Applications on Delay Systems	Coupled tanks are widely used in process control applications in order to mix certain liquid materials while keeping the level of the specific liquids in the tank at desired level. In this project, several PI controllers will be designed for the experimental coupled tank. Then, performance of these controllers will be compared in the experimental setup.	Control Systems (3 Students)
PRJ028	GPS-free outdoor positioning system	Purpose of this project is to design and develop necessary hardware, software and algorithms to locate multiple objects in outdoors without using GPS. Teams are going to design and implement the entire system.	Telecommunication (1) Digital Systems (2)
PRJ029	Indoor positioning of multiple objects	Purpose of this project is to design and develop necessary hardware, software and algorithms to locate multiple objects in indoors. Teams are going to design and implement the entire system.	Telecommunication (1) Digital Systems (2)
PRJ030	Indoor navigation using LiDAR	Purpose of this project is to design and develop necessary hardware, software and algorithms to implement an indoor navigation system using LiDAR. Teams are going to design and implement the entire system.	Telecommunication or Signal Processing (1) Digital Systems (2)